Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Service Rules and Procedures to Govern the	)	
Use of Aeronautical Mobile Satellite Service	)	IB Docket No. 05-20
Earth Stations in Frequency Bands Allocated	)	
to the Fixed Satellite Service	)	
	)	

COMMENTS OF VIASAT, INC.

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ViaSat, Inc. ("ViaSat") submits the following comments in response to the Commission's Notice of Proposed Rulemaking in the above-referenced proceeding ("NPRM").[1] ViaSat is keenly interested in this proceeding because ViaSat is developing technology to make satellite-delivered broadband services available to flight crew and passengers on board commercial and private aircraft. For reasons discussed below, ViaSat supports the Commission's efforts to establish a regulatory framework for routine licensing of Aeronautical Mobile Satellite Service ("AMSS") systems in the Ku-band frequencies. The Commission should also adopt service rules consistent with these comments to promote the efficient use of spectrum, the growth of new communications services, and the widespread availability of broadband services.

I. INTRODUCTION AND SUMMARY

Through this proceeding and other recent proceedings, the Commission properly encourages the flexible use of Ku-band spectrum to make expanded broadband capabilities available to consumers, whether they are on the ground, in the air or at sea. The Commission

[1] *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service*, IB Docket No. 05-20, Notice of Proposed Rulemaking, FCC 05-14 (rel. Feb. 9, 2005).

should promote the widespread deployment of AMSS systems by establishing a regulatory framework that provides AMSS operators not only certainty and protection, but also flexibility to accommodate further development and refinement of network technology. Streamlined procedures for processing AMSS applications will promote the rapid deployment of AMSS for broadband on aircraft because streamlined processing and flexible service rules will significantly reduce the regulatory delays that AMSS applicants face today, as evidenced by the 18 months that it took to prosecute ARINC's recently-granted AMSS application. Such procedures should include provisions to allow blanket licensing of aeronautical earth station ("AES") terminals and the means for routine processing of blanket licensing requests. Additionally, to reduce administrative burdens on both the Commission and applicants, the Commission should adopt service rules that can accommodate a variety of AMSS technologies.

The Commission should adopt service rules that will provide: (1) interference protection with respect to AMSS operations, and (2) flexibility to deploy new and innovative technology. The Commission should accord AMSS co-primary treatment as a fixed satellite service ("FSS"), much in the same way that earth stations on vessels ("ESV") are treated. Such treatment would provide the regulatory certainty and interference protection on which large investments can be made. Moreover, the Commission should adopt the same power density limits that would apply to "traditional" FSS VSAT networks and should allow AMSS operators to meet these limits in the manner they consider best suited for the technology they use. The network aggregate limits that ViaSat proposes in these comments would allow AMSS operators to deploy new and innovative technology without significant delays in the licensing of new AMSS networks, furthering the Commission's goal of fostering the widespread availability of broadband services.

II. THE COMMISSION SHOULD TREAT AMSS AS CO-PRIMARY IN THE KU-BAND FREQUENCIES (NPRM § III.A.)

The Commission should treat AES services no differently from ESVs for purposes of interference protection. Namely, the Commission should recognize AMSS as an application of FSS networks, and therefore should afford them primary status to the extent that AMSS is no more interfering than and no more susceptible to interference than a typical VSAT. As the Commission recognized in the ESV proceeding, doing so would ensure the ability of AES terminals to access multiple satellites following FSS inter-system coordination, and also would facilitate inter-system coordination among FSS operations, because multiple services within the allocation would have primary status.[2] Moreover, treating AES terminals as primary for interference protection purposes would advance the NPRM's stated goals of promoting efficient use of spectrum and meeting growing demand for two-way broadband capabilities for aircraft passengers and crew by offering a less restrictive operating environment with greater (*i.e.*, primary) regulatory rights, and thereby providing certainty to support needed investment.[3] The adoption of adequate technical limitations, as ViaSat proposes, will ensure RF compatibility with other primary FSS applications in these bands.

Even as a primary service, AMSS operators would coordinate operations with space research facilities, as is required for ESV and FSS.[4] ViaSat agrees that AMSS operations should coordinate with the Tracking and Data Relay Satellite System ("TDRSS") in the 14.0-

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[2] *See Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands*, Report and Order, 20 FCC Rcd 674 at ¶¶ 78, 79 (2005) ("ESV Order").

[3] *See* NPRM at ¶¶ 1, 2.

[4] *See id.* at ¶¶ 22, 28.

14.2 GHz band and the Radio Astronomy Service ("RAS") in the 14.47-14.5 GHz band, as the Commission proposes in the NPRM.

III. THE OFF-AXIS EIRP DENSITY LIMITS SHOULD BE THE SAME AS THOSE PROPOSED FOR VSATS (NPRM § III.B.1.A.)

In the NPRM, the Commission proposes power density limits that are different than the limits proposed for VSATs in the Commission's pending Earth Station Licensing Proceeding.[5] The Commission should apply the same limits to AMSS operations as would apply to FSS VSAT networks. The Commission's basis for proposing the VSAT limits applies equally to AMSS operations. As long as the power limits are met, the operation of AES terminals is no different, from the interference perspective of an adjacent spacecraft, than the operation of VSAT terminals. Thus, instead of the limits proposed in the NPRM, the following off-axis EIRP density limits should apply along the geostationary satellite orbital arc:

Angle off-axis	Maximum EIRP Density in any 4 kHz band
$1.5° \leq \theta \leq 7°$	$15 - 25 \cdot \log_{10}\theta$
$7° < \theta \leq 9.2°$	-6
$9.2° < \theta \leq 48°$	$18 - 25 \cdot \log_{10}\theta$
$48° < \theta \leq 85°$	- 24
$85° < \theta \leq 180°$	- 14

Where: Θ is the angle in degrees from the axis of the main lobe.

One difference between the limits proposed in the Earth Station Licensing Proceeding and the proposed limits in this NPRM is the higher maximum EIRP density for off-axis angles beyond 85°. Although ViaSat's AES terminals meet the maximum EIRP density for off-axis angles greater than 48°, AES terminals and small antennas generally are more likely to

[5] *2000 Biennial Regulatory Review – Streamlining and Other Revisions of Part 25 of the Commission's Rules Governing the Licensing of, and Spectrum Usage by, Satellite Network Earth Stations and Space Stations*, IB Docket No. 00-248, Sixth Report and Order and Third Further Notice of Proposed Rulemaking, FCC 05-62 at ¶ 119 (rel. Mar. 15, 2005) ("Earth Station Licensing Proceeding").

need a higher limit for greater off-axis angles because sidelobes of these antennas are more difficult to control than those of larger standard VSAT antennas. There does not appear to be any basis for treating AES terminals differently than VSAT terminals. Thus, the Commission should conform the limits in this proceeding with those proposed in the Earth Station Licensing Proceeding.

Additionally, under the limits proposed in the Earth Station Licensing Proceeding, the antenna gain pattern envelope begins at 1.5° instead of 1°. A wider angle allows smaller earth station antennas to comply with the limits because starting the antenna gain pattern envelope at a wider off-axis angle permits wider main lobes that are characteristic of smaller earth station antennas.[6] In the Report and Order portion of the Earth Station Licensing Proceeding, the Commission concluded that the proposed limits should include an envelope that begins at 1.5° based on its determination that adjacent satellites would be adequately protected by the requirement to maintain orbital longitude within 0.05° of their assigned orbital location.[7] The Commission also concluded that adjacent satellites are further protected by the fact that the difference between geocentric angles (on which the Section 25.209 limits are based) and topocentric angles (under which real-world operations occur) provides an additional safeguard against harmful interference to adjacent satellites. The topocentric angle is always greater than the geocentric angle, and a 2° geocentric angle equates to a 2.1° to 2.2° topocentric angle, thereby providing a 0.1° to 0.2° margin of error.[8] The Commission's conclusions apply equally to AMSS networks, and thus, the power density limits proposed for VSATs should also be the basis for limits on AMSS terminals.

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[6] *Id.* at ¶ 12.

[7] *Id.* at ¶ 22; 47 C.F.R. § 25.210(j).

[8] Earth Station Licensing Proceeding at ¶ 22.

IV. THE COMMISSION SHOULD ALLOW AMSS OPERATORS FLEXIBILITY TO MEET OFF-AXIS EIRP DENSITY LIMITS IN THE MANNER BEST SUITED FOR THE TECHNOLOGY EMPLOYED (NPRM § III.B.1.A.)

A. AMSS Operators Should Be Free To Determine Whether Power Density Should Be Controlled On An Individual Or Aggregate Basis

ViaSat agrees with Boeing's view that to protect satellite operations in a 2-degree spacing environment, AMSS licensing rules need ensure that the *aggregate* off-axis EIRP density of all co-frequency AES transmissions in a network will not exceed the levels generated by a routinely authorized FSS transmitter under Section 25.134(a)(1).[9] AMSS operators typically have the flexibility to manage the aggregate off-axis EIRP density of the AMSS network through the network management control center ("NCMC"). The Commission should allow AMSS carriers to determine whether the NCMC manages the off-axis EIRP density on a network wide or individual terminal basis. Whether the limit is managed on an aggregate or individual basis will be determined by the overall system design and the network management system used. For instance, in a network that does not have a complex network management system, power density for the network could be controlled manually. The operator of such a system may prefer to control the power density limit of each AES terminal individually.

In contrast, an aggregate limit is preferable in a CDMA network with a sophisticated network management system, such as ViaSat's AMSS network. As explained in further detail below, ViaSat's AMSS network would be comprised of various antenna types, operating at various data rates. Additionally, AES terminals operating in different parts of the satellite footprint would require different power levels to achieve a consistent quality of service. ViaSat's NCMC would have the capability of controlling the network total aggregate EIRP

[9] NPRM at ¶ 35.

density such that the aggregate limit is met for the network, while ensuring the most efficient distribution of power to terminals throughout the network.

Further, the Commission's rules on off-axis EIRP density should be technology neutral. Applying specific limits to specific components of a system could constrain certain network operations or designs. To avoid such a restraint on innovation, the Commission should establish an aggregate network-wide limit and give AMSS operators wide latitude to operate in any manner within the limit.

In this regard, the Commission should follow the approach adopted in its proceeding to establish service rules for ancillary terrestrial component ("ATC") to MSS in the L Band frequencies. In its initial order establishing service rules for ATC, the Commission adopted a number of technical rules to prevent harmful interference from ATC into MSS operations, including specific power limits applicable to a specific network configuration.[10] However, on reconsideration, the Commission adopted a revised framework for ATC service to make it easier for MSS operators to deploy ATC through different types of technology, and using different technical parameters, than those originally proposed. The Commission recognized that adopting a general power limit to apply to the entire network "allows MSS/ATC operators freedom to design their systems to meet a limit on uplink interference in the manner that they think best promotes the efficiency and utility of their service offering."[11] The Commission acknowledged that MSS/ATC operators are in a better position than the Commission to make decisions regarding the interference trade-offs between services that will produce the best

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[10] *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Bnad, the L-Band, and the 1.6/2/4 GHz Bands*, IB Docket No. 01-185, Memorandum Opinion and Order and Second Order on Reconsideration, FCC 05-30 at ¶ 40 (rel. Feb. 25, 2005) ("ATC Second Order on Reconsideration").

[11] *Id.* at ¶ 47.

service.[12] Even for a secondary service, such as ATC, the Commission allowed providers great latitude to meet the power limits in any manner.

Likewise, the Commission should not adopt an overly-restrictive regulatory scheme for AMSS networks by providing specific limitations on operations. An aggregate network limit that AMSS operators can apply on an individual antenna or network aggregate basis would be sufficient to prevent harmful interference into adjacent operations, but would not constrain the development of new and innovative AES technology.

B. The Power Density Limits Should Account For Spread Spectrum Modulation Techniques

1. The power density factor should account for non-homogenous AES terminals operating under varying conditions.

The Commission should also adopt an alternative limit for networks using spread spectrum modulation techniques coupled with a code division multiple access method (CDMA). The Commission's proposed formula for a reduction of the single-antenna limit for networks using CDMA does not adequately account for variations in power density among transmitters in the network resulting from differences in AES terminal design, data rates, satellite performance contours and spreading factors. The power density limit for a single AES terminal as applied to a network of AES terminals employing CDMA should reflect these variables in order to allow AMSS operators to use the available network capacity in the most efficient manner.

Power control is a key aspect of most CDMA systems. In a well-designed CDMA network, the network operator can control the power to all transmitters so that each transmitter uses the *minimum* power necessary to communicate with the satellite at the desired quality of service. In order to maintain a consistent quality of service among antennas in the

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[12] *Id.*

network, and in order to maximize system efficiency, the network controller must take into account: (i) the different technical characteristics of each terminal operating within the network, and (ii) the differing propagation and satellite performance characteristics affecting the environment in which each terminal operates. Additionally, the network controller must account for the various factors that affect the level of power required to be transmitted from an AES terminal and the resulting power density to be received at the spacecraft. These include, for example, the satellite performance in the direction of the AES terminal, range to the satellite, rain and atmospheric attenuation,[13] antenna pointing, transmitted data rate, chip rate of the spreading code, and number of simultaneous transmitters. In addition to managing the aggregate off-axis EIRP density that creates the potential for interference into adjacent spacecraft, the network also must manage the self-interference created by other co-frequency users within the CDMA network.

The Commission's proposed factor of 10*log(N) is overly simplistic because it assumes that the network is made up of homogeneous AES transmitters, each operating on the same channel, transmitting in the same satellite performance contour, *and at the same time*. Essentially, it provides for a proportionate reduction in power, based only on the maximum number of simultaneously operating terminals in the network. But such an approach does not adequately account for the variables mentioned above, would result in an inefficient distribution of power among the terminals in the network, and therefore would not allow a CDMA network operator to maximize the throughput of its network. Requiring use of the proposed factor would severely reduce the broadband traffic capacity of the network as a whole.

[13] Rain and atmospheric attenuation must be factored into the AES uplink EIRP, but do not impact the off-axis EIRP density received at the spacecraft because the extra power is "burned off" through signal attenuation by the time it reaches the satellite arc.

If all AES terminals in a CDMA network were required to transmit at a power setting equal to the limit reduced by 10*log(N), the assumed power level for each AES terminal would be that of the smallest antenna operating in the most technically disadvantaged part of the satellite footprint (*i.e*, the area with the worst G/T). Therefore, the power level represented by this factor, although appropriate for the most disadvantaged AES terminal, would be much higher than that needed to be used by other, less "technically challenged" AES terminals in the network. As a result, AMSS operators would be unable to maximize the efficiency of the network. If the AES terminals each transmit just enough power to arrive at the hub demodulator at the nominal level, then the extra power that would have been allotted to better-performing AES terminals (*i.e.*, larger antennas in areas with good satellite coverage) could instead be reallocated to more disadvantaged AES terminals, used to increase the throughput of more advantaged AES terminals, or used to add additional AES terminals to the network. However, the 10*log(N) approach would prevent a network operator from reallocating this available network power in such a manner.

Similar inefficiencies would result from failing to account for variations in data rates used by AES terminals. The power level of AES terminals within a CDMA network varies with different data rates. For example, ViaSat's Arclight product utilizes CDMA and supports user transmit data rates of 32, 64, 128, 256, and 512 kbit/s. For most data rates, the system would typically be operated at the maximum chip rate that will allow the signal to fit inside the host transponder.[14] Based on an assumption that all users are spread to a similar 28 MHz, the EIRP density of an AES operating at 128 kbit/s would be twice that of one operating at 64 kbit/s. Similarly the EIRP density of AES terminals operating at 256 kbit/s and 512 kbit/s would be,

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[14] The exception is the 32 kbit/s data rate, which only spreads to a maximum of 14.4 MHz.

respectively, four and eight times higher than the AES transmitting at a data rate of 64 kbit/s. Thus, if the system supported "N" 512 kbit/s AES terminals, the system could support 2*N 256 kbit/s, 4*N 128 kbit/s, and 8*N 64 kbit/s AES terminals.[15] Under the basic allocation formula proposed in the NPRM, the power level allocated to each terminal would be based on the highest data rate. Thus, the power level allocated to lower data rate terminals would be higher than required, but any network power not consumed by the lower data rate terminals could not be reallocated to higher data rate terminals.

A more efficient use of the system capacity is to control the power to each individual AES terminal, based on its individual performance characteristics, and the RF environment in which it operates. Doing so would allow the operator to maintain a consistent quality of service among antennas in the network, while still adequately protecting adjacent satellites from harmful interference. The Commission therefore should adopt the aggregate off-axis EIRP density of a non-homogeneous network of "N" technically different AES terminals, each operating at different parameters, to be the sum of the individual AES off-axis EIRP densities, represented by the following formula:

$$Aggregate\_OAED = 10 * \log\left[\sum_{i=1}^{N_{AES}} 10^{AES\_OAED_i/10}\right]$$

where Aggregate_OAED is network aggregate off-axis EIRP density and AES_OAED_i is the off-axis EIRP density from the *i*th AES in the network. The aggregate off-axis EIRP density of the network as calculated by this formula shall not exceed the FCC off-axis EIRP density mask except as proposed in Section IV.B.2., below, regarding contention protocols.

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[15] Alternatively, to accommodate a 32 kbit/s data rate, the system would allow the 32 kbit/s transmissions to operate co-frequency with the 64, 128, 256, 512 kbit/s terminals even though the 32 kbit/s transmissions are only spread to 14.4 MHz.

2. The Commission should allow AMSS networks using contention protocols to exceed the limits for short periods of time.

Contention protocols allow multiple terminals in a network to communicate using the same frequencies by managing the transmission of data throughout the network, thereby allowing the network operator to use spectrum more efficiently. In a TDMA network using a contention protocol, data transmissions, or "bursts" may sometimes overlap, resulting in short periods of time where the network operates at a higher power. When contention protocols are employed, AES terminals may exceed the off-axis EIRP density mask for short periods of time when data transmissions occur simultaneously ("collisions"). The Commission recognized in the Earth Station Licensing Proceeding that use of contention protocols can increase the efficiency of VSAT networks.[16] Therefore, the Commission proposed the following contention table to adjust the power density limits to allow operators to take advantage of these efficiencies:

Percentage of Time	Increase in Aggregate EIRP Allowed *
10% (10^{-1})	0 dB
1% (10^{-2})	2 dB
0.1% (10^{-3})	4 dB
0.01% (10^{-4})	6 dB
0.001% (10^{-5})	8 dB
0.0001% (10^{-6})	10 dB
0.00001% (10^{-7})	12 dB
0.000001% (10^{-8})	14 dB
0.0000001% (10^{-9})	16 dB

* The baseline for this power increase is – 14 dBW/4 kHz.[17]

In the Earth Station Licensing Proceeding, the Commission tentatively concluded that these limits strike a reasonable balance between protecting adjacent satellites from harmful interference and allowing VSAT network operators to make efficient use of their facilities.

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[16] Earth Station Licensing Proceeding at ¶ 103.

[17] *Id.* at ¶ 119.

VSAT network operators would have substantial flexibility to use contention protocols because the operators could exceed the envelope by increasing amounts, provided that the amount of time that they exceed the envelope is sufficiently low.[18]

AMSS networks that utilize contention protocols should be allowed the same level of flexibility to take advantage of the same types of efficiencies made possible by modulation. ViaSat's Arclight system employs a CDMA random access technology that uses code reuse multiple access ("CRMA"). In the CRMA protocol, once an AES terminal has been allowed access to the network, it does not transmit signals continuously, but rather only transmits when users send data. User data in a CRMA network is sent immediately upon transmission to the AES terminal. Unlike some other contention protocols such as TDMA and Aloha, no framing or time scheduling is required. Instead, the CRMA access method has truly random access.

Also unlike other access/contention protocols, such as TDMA and Aloha, where multiple transmissions arriving within a window result in a total loss of data for all transmitters, in a CDMA network, multiple transmissions will still be properly demodulated. However, as with any CDMA system, the various bursts on top of each other add to the overall mutual interference level at the receiver. As the mutual interference level rises above a certain point the bit error rate for all users will increase.

Although the CRMA access method that Arclight uses is a form of a "contention" protocol, there are few actual "collisions" in normal operation since data bursts transmitted simultaneously within the network are unlikely to arrive within a window of the same few chips in the start of the spreading code and thus, are not likely to interfere. Characteristics of the data

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[18] *Id.* at ¶ 120.

transmissions in ViaSat's Arclight network further reduce the "collisions." On average, there will be a large population of AES terminals in the network that are idle and not transmitting power to the satellite. As users send mouse clicks, enter URLs, or send emails, the user's AES terminal will immediately begin to "burst" data. Statistically, the traffic bursts will arrive in a well defined probability distribution. Based on the average rate of burst arrival, the network can manage the data transmissions and ensure that the average number of AES terminals transmitting is such that interference within the network as well as the off-axis EIRP are within the prescribed limits.

Thus, the Commission should adopt an exceedance allowance for AMSS operators based on the limits proposed in the Earth Station Licensing Proceeding. ViaSat's AMSS systems utilize a contention protocol, and as the Commission recognized in the Earth Station Licensing Proceeding, some level of increased power over the defined off-axis EIRP density mask for short periods of time would be appropriate to accommodate the increased network efficiency enabled by contention protocols.

V. THE COMMISSION SHOULD PERMIT VARIANCES IN OFF-AXIS EIRP DENSITY DUE TO VARIATIONS IN ANTENNA PERFORMANCE

ViaSat agrees with Boeing's argument that the Commission should permit minor variances in off-axis EIRP density for variations in antenna performance where adjacent satellites are not adversely affected.[19] ViaSat respectfully requests that the Commission also consider variations in antenna performance in the elevation plane. Currently, the Commission's rules require GSO FSS antennas to comply with the antenna gain pattern envelope in both the

[19] NPRM at ¶ 38.

GSO plane and the elevation plane.[20] The Commission's NPRM in this proceeding only addresses off-axis EIRP density along the geostationary satellite's orbital arc and does not address interference potential of AMSS operations into NGSO satellites.[21]

Because AES terminals often must have a low profile, the main beam of these terminals usually is wider in the elevation plane than in the azimuth plane. As a matter of safety and practicality, antennas installed on aircraft must be designed to minimize drag on the airframe. Thus, such antennas are usually designed with a low profile. The size and design of the aircraft determines the type of antenna that can be accommodated. For instance, many larger business jets and most commercial jets can accommodate a tail mounted antenna that is circular or parabolic in shape. However, smaller aircraft typically must rely on a fuselage mounted antenna. Fuselage mounted antennas must have a lower profile, typically less than 4 inches in height, but may have a larger width – up to approximately 24 inches depending upon the aircraft. Based on ViaSat's evaluation of typical low-profile antennas, in the azimuth plane, these antennas perform similarly to or even better than the circular reflector antennas commonly in use on aircraft today. However, due to the shorter height of low-profile antennas, the elevation beamwidth from these antennas is often much wider than from circular antennas.

The size and shape of the antenna used with the AES terminal will determine the characteristics of its main beam. For instance, conventional circular parabolic tail mount antennas typically have 3 dB beamwidths of approximately 5º - 6º (i.e., 2.5º - 3º each side of boresight). The azimuth and elevation patterns will be similar in characteristics and will be independent of azimuth or elevation pointing angle.

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[20] 47 C.F.R. § 25.209(a)(1), (2).

[21] *See* NPRM at ¶ 36.

Low profile fuselage mount antennas, on the other hand, must use technologies other than conventional circular reflectors and include, for example, flat active array, VICTS, slotted waveguide arrays, and lens antennas. While many of these antennas have better beamwidth performance in the azimuth plane than the circular parabolic tail mount antenna, the elevation beamwidth can often be much wider. Those technologies that use electrical or mechanical scanning of an array will have elevation beamwidths that vary with elevation angle to the satellite. This is because the effective height of the minor axis of the array aperture varies as the cosine of the scan angle. If the array is mounted flat, the elevation beamwidth at a 30º look angle to the satellite will be twice as wide as boresight (*i.e.* a 90º look angle). Additionally, sidelobe levels may increase at higher scan angles.

Those technologies that utilize mechanically steered slotted waveguide arrays, lens, or other design will generally have a fixed elevation beamwidth that is a function of the effective height of the array. For example, a 4 inch tall by 24 inch wide array will have an elevation beamwidth on the order of 12º - 15º (6º - 7.5º to either side of boresight). The azimuth beamwidth, however, would be on the order of 2º (1º to either side of boresight). These beamwidths would be independent of pointing angle.

AMSS operators using such low-profile antennas can reduce the input power density of these antennas to meet the proposed off-axis EIRP density limits in the elevation plane. However, constraining the input power density could severely limit the capacity of the individual antenna or conversely the aggregate network capacity.[22] There are no commercial NGSO Ku-band systems currently in operation or planned to be deployed in the foreseeable

[22] The power reduction that would be required to meet the mask is dependent upon the characteristics of the main beam of the antenna.

future with which AMSS operations would interfere. The Commission therefore should amend its rules to allow greater power in the elevation plane in order to allow these AES terminals to be deployed and used to provide broadband services on a widespread basis.

Because there are currently no NGSO operations into which AES terminals would interfere, the Commission could authorize AMSS licensees to operate at a higher power in the NGSO plane pursuant to a waiver. However, the uncertainty created by this solution is likely to limit the deployment of AES terminals. AMSS operators would need to determine as a business matter whether the fixed costs of providing AMSS service could be recovered in the event that the operator would be required to constrain the power in the elevation plane, thereby reducing the capacity of the network. The existence of such a risk is likely to stunt the growth of broadband deployment on aircraft. Therefore, the Commission should not rely on waivers as a long-term solution because doing so would constrain a service and a technology that exist today to preserve the possibility of another service that may never exist in the future. The Commission should examine this issue further and consider a relaxation of the antenna gain pattern in the NGSO plane.

VI. AN ANTENNA POINTING REQUIREMENT IS UNNECESSARY FOR AES TERMINALS (NPRM § III.B.1.B.)

The Commission should refrain from adopting an antenna pointing requirement for AES terminals. Adopting an aggregate power density limit as proposed above obviates the need for restrictions on antenna pointing errors, because AMSS operators can control interference from mispointed antennas by managing the overall power of the network. The proposal in the NPRM to adopt a pointing accuracy requirement of 0.2º therefore is unnecessarily rigid. Such a requirement would add unnecessary expense and complexity to AES terminals, and would hinder the development of AMSS technology and the growth of AMSS services. In the Earth Station Licensing Proceeding, the Commission determined that "a complex showing of minimum pointing error is unnecessary" given the streamlined licensing procedures under which a VSAT applicant would reduce its power levels so that the earth station appears like a routine earth station to adjacent satellites.[23] The same holds true for an AMSS network where aggregate power density is controlled by an NCMC.

In a CDMA network, the contribution of random antenna pointing errors from each terminal is miniscule relative to the overall off-axis EIRP density in a large network. A single antenna in a CDMA network of 100 technically equivalent AES terminals uses 1/100th of the power density of a single antenna in a typical VSAT network. Thus, a single mispointed antenna in such a network would be undetectable to adjacent satellite users. Therefore, a pointing accuracy requirement would be wholly irrelevant in such a scenario.

Even in this CDMA network scenario where several antennas are mispointed, the aggregate affect of the pointing errors would only be a small increase in power into adjacent networks. In CDMA networks, aggregate pointing errors do not have a significant impact. Due to the mobile nature of AES terminals, the environment is constantly changing. Therefore, the likelihood of a pointing error is randomly distributed. There is no pattern in how errors occur. Because the errors are random and because the number of severely mispointed errors are relatively low, an increase in power into an adjacent satellite due to one antenna is likely to be offset by a decrease in power due to other antennas mispointed in different directions. Thus, even assuming a worst-case scenario of pointing errors, there is very little impact on the aggregate network power into an adjacent satellite.

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[23] Earth Station Licensing Proceeding at ¶ 23.

In order to comply with a 0.2-degree pointing accuracy requirement, AES terminals would need to be deployed along with precise inertial reference units, costing tens of thousands of dollars apiece. Thus, a pointing accuracy requirement would be overly burdensome, given that the interference to adjacent satellites is not likely to be great. Instead, network operators can factor into the budget for meeting the off-axis EIRP density mask the increased power resulting from pointing errors.

In this regard, it is important to recognize that, as a general matter, AMSS antennas do not comply with the Commission's rule Section 25.209 mask at 2 degrees, because of the width of the main beam. As set forth above, that interference potential raised by that technical characteristic can readily be resolved in a network using spread spectrum and CDMA access techniques through the "power/pattern" tradeoff that ViaSat proposes in these comments.

Because the main beam of a typical AES terminal already exceeds the Section 25.209 mask at 2°, the additional impact of antenna mispointing is not significant. More specifically, mispointing in excess of 0.2° in the direction of the adjacent satellite would result in a very small increase in interfering power. And, as noted above, the impact of that effect would likely be offset by the mispointing in the opposite direction of another terminal in the same network. More fundamentally, the network operator is able to reduce the overall network power to account for the impact of this issue, just as it is able to adjust the power to account for the use of non-Section 25.209 compliant antennas. Thus, imposition of a 0.2-degree antenna pointing accuracy requirement would add cost and complexity to the deployment of broadband AES terminals without providing any additional protection to adjacent satellites.

Furthermore, the Commission should not require AMSS applicants to provide information in connection with variations in transmit EIRP density and antenna patterns due to manufacturing, aging and environmental effects.[24] The Commission does not require VSAT applicants to provide this information because these variations are not significant issues for VSAT terminals. Due to the sophisticated nature of aeronautical terminals and the rigorous standards that have to be met to install such terminals on aircraft, AES terminals are more precise and robust than most fixed earth stations licensed on a blanket basis. Moreover, satellite terminals on aircraft receive a high level of routine maintenance. Thus, variations due to manufacturing, aging and environmental effects are particularly insignificant in the case of AES terminals. Requiring AMSS applicants to provide such information would create administrative burdens and hinder the deployment of AMSS networks and the provision of broadband service.

VII. OTHER ISSUES

A. Licensing Issues (NPRM § III.C.)

The Commission should allow both blanket licensing and individual licensing of AES terminals.[25] As long as the operation of terminals complies with the rules, it should not matter whether an operator desires a license to operate a single terminal or to deploy numerous identical terminals over the U.S. As discussed above, the Commission should take a technology neutral approach to developing rules for AMSS operations. Thus, licensing rules for this service should be flexible enough to accommodate a wide range of applications for AMSS technology.

The Commission should also allow AMSS operators to receive authority to operate with any U.S. licensed satellite and non-U.S. satellite on the Permitted List ("ALSAT" authority).[26] Granting ALSAT authority would help ensure the viability of broadband services on board aircraft by allowing AMSS operators the flexibility to negotiate with multiple satellite

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[24] *See* NPRM at ¶ 41.

[25] *See id.* at ¶¶ 48, 50.

[26] *See id.* at ¶ 51.

capacity providers. By allowing the parties to negotiate market-based prices for transponder capacity, ALSAT authority would enhance competition and reduce the costs of providing AMSS services. The Commission adopted rules to permit ALSAT authority to ESVs based on similar reasoning.[27]

B. Control of AES Terminal Transmissions (NPRM § III.B.1.c.)

The control features in an AMSS system will provide assurance of compliance with the rules and will help ensure that these systems will not cause harmful interference to other users of the Ku-band. Therefore, AES terminals that use closed loop tracking should have some form of built-in protection to prevent unintended satellite tracking by ensuring that transmission is inhibited when the antenna is not pointed correctly.[28] ViaSat agrees that AES terminals should be capable of self-monitoring and be equipped with an automatic shut off if the terminal detects a fault that would cause harmful interference.[29]

ViaSat also agrees that AES terminals should at a minimum be able to receive "enable transmission" and "disable transmission" commands from the NCMC.[30] However, a "parameter change" command should result in a cessation of transmissions by the AES only until the parameter change is complete. AES terminals should be able to automatically resume transmissions without an "enable transmission" command from the NCMC to restart transmissions.

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[27] ESV Order at ¶¶ 105, 106.

[28] *See* NPRM at ¶ 42.

[29] *See id.* at ¶ 44.

[30] *See id.* at ¶ 43.

C. Tracking (NPRM § III.D.)

ViaSat understands the need to track AES operations to enforce interference protections.[31] However, the Commission should not require AMSS operators to include in tracking data the exact antenna pointing angles. As explained above, effects of individual antenna pointing error are insignificant in a CDMA system. In any event, the utility of such data is questionable given that short term antenna mispointing may not be picked up by such data, depending on the sampling and reporting rate.

Additionally, ViaSat proposes that aircraft locations not be publicly disclosed.[32] While ViaSat's system can track and log AES locations, many customers require that location information of the AES not be disclosed for safety, security, and business intelligence reasons. Government agencies have also expressed concerns regarding this information as it relates to national security, law enforcement, or military operations. The Commission recognizes such security concerns in proposing to limit "real time" public access to exact aircraft locations.[33] The Commission should similarly limit public access to aircraft locations generally.

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[31] *See id.* at ¶ 54.

[32] *See id.*

[33] *Id.*

For the foregoing reasons, ViaSat respectfully requests that the Commission adopt service rules for AMSS operations consistent with these comments.

Respectfully submitted,

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ENGINEERING INFORMATION CERTIFICATION

I hereby certify that I am the technically qualified person responsible for reviewing the engineering information contained in the foregoing submission, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this pleading, and that it is complete and accurate to the best of my knowledge and belief.

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